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Exploring the limits of in-situ U-Pb dating of metamorphic garnet

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Recent advances in analytical techniques and instrumentation allow for the analysis of increasingly smaller sample volumes and lower concentrations. This development significantly expands the possibilities of in-situ geochronology, *e.g.*, LA-MC-ICPMS. Minerals with low U (and Pb) contents such as garnet become the target of in-situ U-Pb geochronology since ages can potentially be obtained from single (sub-)mm-sized garnet grains in thin sections. In this contribution, we explore the current limits of in-situ U-Pb geochronology: what are the minimum concentrations from which an accurate and precise U-Pb age can be obtained?

For that purpose, we have analysed garnets from three different localities that were unsuccessfully analysed in the past using a single-collector sector-field Element XR instrument at FIERCE. These garnets have been re-analysed at FIERCE using a Neptune Plus MC-ICPMS coupled to a RESOLution-LR ArF Excimer laser. The analyses were performed in static mode measuring the masses ²⁰⁶Pb and ²⁰⁷Pb with Secondary Electron Multiplier (SEM) and ²⁰²Hg, ²⁰⁴Pb and ²³⁸U with the Multiple Ion Counters (MIC). With a spot diameter of 193 μ m (round) and a fluence of 2 J/cm² at 15 Hz, ca. 18 μ m pit depth was ablated in 18s analysis time, resulting in a total of 2 μ g of ablated material. This is more than 2,000 times less material compared to conventional isotope dilution analyses and 3,000 times less U than for a typical LA-ICPMS zircon analysis (20 μ m spot). Although the analysed garnets typically have U contents below 10 ng/g, about 15–30 spots are commonly sufficient to define a regression line in the Tera-Wasserburg diagram, yielding a precision of typically <3 % for the lower intercept age. Challenges and details of the method will be discussed using samples of metamorphic garnet from Kaapvaal craton granulites and Eastern and Western Variscan eclogites.